ETHEOSTOMA BOSCHUNGI, A NEW PERCID FISH FROM THE TENNESSEE RIVER DRAINAGE IN NORTHERN ALABAMA AND WESTERN TENNESSEE

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ABSTRACT

Etheostoma **boschungi**, the slackwater darter, is described from 110 specimens taken from second and third order streams in the southern bend of the Tennessee River. It appears to be an eastern representative of a species group whose other members, *E. punctulatum*, *E. cragini*, and *E. pallididorsum*, are found in western drainages of the Mississippi River Basin. *E. boschungi* differs from its western relatives in details of pigmentation, squamation, and osteology.

INTRODUCTION

In 1968, Dorothy A. Sentz of Florence, Alabama brought to our attention an undescribed species of darter which she and Charles Gooch had collected from Lindsey Creek, a tributary of Cypress Creek of the Tennessee River system in Lauderdale County, Alabama.

Subsequently, we visited Lindsey Creek and obtained additional specimens. Shortly thereafter, Charles Gooch informed us of specimens that he had taken during the summer of 1968, in the course of a survey he was conducting of the fish fauna of the Cypress Creek drainage.

Following presentation of our discovery at the meeting of the Southeastern Division of the American Society of Ichthyologists and Herpetologists in April of 1969, Ralph Yerger informed us that he had, on loan from the University of Tennessee, a collection of darters which included a single specimen that closely resembled the species we were describing. We examined the specimen, which had been collected by David Etnier and his students in August 1967, from the Buffalo River, and found it to be conspecific with the specimens from Lindsey Creek. In the Fall of 1969, David Etnier informed us that R. B. Fitz, of the Tennessee Valley Authority, had collected the species in the Flint River, Madison County, Alabama.

We acknowledge with gratitude the assistance of the persons noted above who advised us of collecting localities and supplied specimens for examination. We are indebted to a number of other persons who provided aid in various ways. Albert P. Blair loaned preserved specimens and color transparencies of *Etheostoma cragini*, Frank B. Cross loaned preserved specimens of *E. cragini* and *E. pallididorsum*, and color transparencies of *E. cragini* and *E. punctulatum*, Glenn H. Clemmer and W. Mike Howell provided specimens of the darter being described, assisted in the field, and reviewed the manuscript, Carter R. Gilbert loaned specimens of the darter being described, and Franklin F. Snelson loaned color transparencies of *E. cragini* and *E. punctulatum*. Gene Beckham, Hector Harima, and Maurice Mettee assisted in the field work.

Cephalic canal pores were counted in the manner described by Hubbs and Cannon (1935), transverse scale rows were counted according to the methods of Bailey (1959), and vertebral counts were made following the methods of Bailey and Gosline (1955).

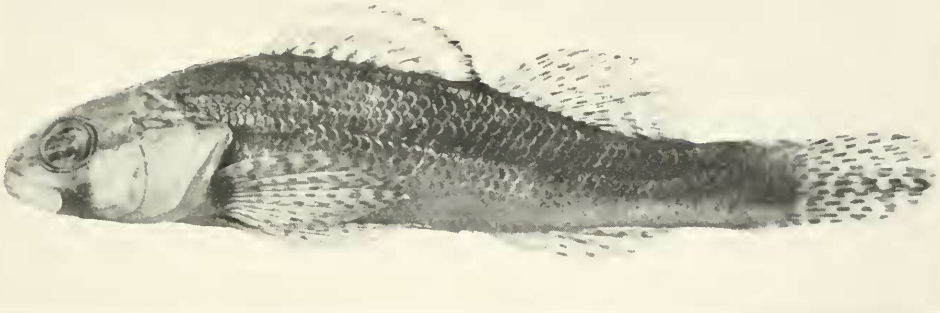

Figure 1. *Etheostoma boschungi*, new species. Paratype, UAIC 3973, adult male, 46.9 mm SL, from Copeland Branch, tributary to Briar Fork of Flint River, Madison Co., Alabama, 24 October 1970.

The methods of Hubbs and Lagler (1958) were employed in obtaining all other meristic and morphometric data.

We take pleasure in naming this new darter in honor of Herbert T. Boschung, Jr., Director of the Museum of Natural History, University of Alabama, in recognition of his contributions to ichthyology and his inspiration and devotion to his students.

Etheostoma (*Oligocephalus*) *boschungi*, sp. nov. Slackwater Darter

(Fig. 1)

Material.—The holotype, Tulane University, TU 79424, an adult male, 50.7 mm standard length, was collected from Lindsey Creek at the junction of Lauderdale County Roads 15 and 6, 0.8 mile north of Alabama Highway 20 at Central Heights, Lauderdale Co., Alabama (T1S; R12W; Sec. 3) on 22 November 1969 by Charles Gooch and James D. Williams. Of the 12 paratopotypes taken with the holotype, six specimens (32–55 mm SL) were deposited at the University of Alabama Ichthylogical Collection, UAIC 3774, and six specimens (43–50 mm SL) at Tulane University, TU 79425. Other paratopotypes were taken 22 December 1971 (TU 79427, 15:30–45); 29 November 1968 (UAIC 3210, 1:38); 7 December 1968 (UAIC 3204, 11:28–52); 25 January 1970 (UAIC 3961, 1:48); 22 March 1969 (United States National Museum, USNM 206421, 2:32–33); 19 July 1968 (USNM 206419, 1:46); 29 January 1969 (University of Michigan Museum of Zoology, UMMZ 197691, 3:29–34); and 19 April 1969 (University of Kansas, KU 14638, 8:30–36).

Paratypes include the following: Alabama—Lauderdale Co.: University of Florida, UF 18424 (1:40) Greenbriar Branch, trib. of Middle Cypress Cr. at Cloverdale (T1S; R12W; Sec. 26), 21 December 1968; UAIC 3206 (1:49) Lindsey Cr., 1.2 miles N of Ala. Hwy. 20 on Co. Rd. 5 (NE ¼, NE ¼, Sec. 30; T1S; R12W) 7 December 1968; UMMZ 197693 (2:42–46) Middle Cypress Cr. at Bethel Grove Church, just off Lauderdale Co. Rd. 11 (T1S; R11W; Sec. 5) 26 October 1969; UMMZ 197692 (2:47–51) Burcham Cr. on Natchez Trace Parkway (T1S; R12W; Sec. 31) 1 November 1969; USNM 206420 (6:28–33) Lindsey Cr. 0.6 mi N of Ala. Hwy. 20 on unnumbered dirt road (T1S; R13W; Sec. 24) 29 January 1969; University of Tulsa Museum, UTC 571 (2:31–37) Lindsey Cr. 0.6 mi N of Ala. Hwy. 20 on unnumbered dirt road (T1S; R13W; Sec. 24) 22 March 1969. Madison Co.: TU 79426 (6:36–46) Copeland Branch, trib. of Briar Fork of Flint R. on West Limestone Rd. (T1S; R1W; Sec. 26) 24 October 1970; UAIC 3973 (15:32–53) Copeland Br., trib. of Briar Fork of Flint R. on West Limestone Rd. (T1S; R1W; Sec. 26) 24 October 1970; UT 91.506 (4:28–34) West Fork of Flint R., Hazelgreen, 9 August 1969; UT 91.507 (1:20) Briar Fork of Flint R., 8 August 1969.

Tennessee—Lawrence Co.: Buffalo R., 9.9 mi N of Lawrenceburg on U.S. Hwy. 43. Florida State University, FSU 16408, 20 April 1969 (3:34–36); Mississippi State University, MSU 809, 11 March 1969 (1:34); UF 16537, 20 April 1969 (2:31–32); University of Tennessee, UT 91.101; 11 August 1967 (1:27); UT 91.331, 26 August 1969 (8:33–50).

The following material was used for comparison with *Etheostoma boschungi*.

Etheostoma cragini Gilbert. Kansas—Meade Co.: KU 3957 (19) Unnamed Cr. above Fish Hatchery, 14 June 1958; KU 8569 (57) Crooked Cr., 8 mi S and 2.5 mi W of Meade, 17 July 1964; UAIC 1810 (5) Crooked Cr., 8 mi S and 2.5 mi W of Meade, 17 July 1964; UMMZ 176858 (45) State Park, below dam, 26 June 1952; UMMZ 156694 (36) small stream, 1.5 mi N of Fowler, 1 January 1949. Sedgwick Co.: KU 12679 (10) Clear Cr. (T29S; R3W; Sec. 3) 13 July 1967. Stafford Co.: KU 12184 (14) Rattlesnake Cr. (T25S; R15W; Sec. 24–25) 1 April 1967. Missouri—Newton Co.: KU 7233 (2) trib. of Shoal Cr. at Neosho, 5 April 1961.

TABLE 1. Frequency distribution of lateral line scales, caudal peduncle scales, and transverse scales in *Etheostoma boschungi*, *E. pallididorsum*, and *E. cragini*.

	Total Lateral Line Scales																				
	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58		N	$\bar{x}$	SD
E. boschungi																					
Buffalo R.									4	2	2	2	1		2		1		14	52.57	2.93
Cypress Cr.			3	4	5	8	7	9	6	3	3	1		1					50	48.24	2.44
Flint R.		2	2	0	0	2	2	3	2	3	1	1	0	1					19	48.63	3.36
Total		2	5	4	5	10	9	12	12	8	6	4	1	2	2		1		83	49.06	3.11
E. pallididorsum			5	11	7	14	19	12	18	4	5								95	47.99	2.12
E. cragini	1	1	2	5	7	6	12	15	14	9	8	6	7		1	1			95	49.44	2.92

	Pored Scales																				
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44		N	$\bar{x}$	SD		
E. boschungi																					
Buffalo R.					1		3	4	1	2	1				1		13	37.70	2.46		
Cypress Cr.		2	2	7	5	3	7	4	7	3	1	1	1				43	36.05	2.70		
Flint R.	3	0	1	0	2	2	2	4	2	1	1	1					19	35.58	3.27		
Total	3	2	3	7	8	5	12	12	10	6	3	2	1		1		75	36.05	2.87		

	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	N	$\bar{x}$	SD
E. pallididorsum		1	5	10	15	18	15	12	8	8	5	1	2							100	12.86	2.39
E. cragini	2	3	2	3	4	6	8	8	8	7	13	11	9	6	2	2		1	1	96	15.37	3.77

	Unpored Scales																				
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			N	$\bar{x}$	SD	
E. boschungi																					
Buffalo R.						1		1	5	1	2	1	1	1				13	15.00	2.16	
Cypress Cr.	1		3	1	2	7	7	6	6	6	2	1	1					43	12.54	2.55	
Flint R.				2	3	2	1	3	2	2	1	2	1					19	13.00	2.83	
Total	1		3	3	5	10	8	10	13	9	5	4	3	1				75	13.08	2.69	

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	N	$\bar{x}$	SD
E. pallididorsum		1	2	1	2	6	9	9	14	8	8	8	10	7	5	5			95	35.17	3.29
E. cragini	1	3	3	3	7	7	9	12	13	10	10	3	3	2	3	2	3	1	95	33.86	3.70

TABLE 1. *Continued.*

	Caudal Peduncle Scales 20	21	22	23	24	25	N	x̄	SD
E. boschungi									
Buffalo R.				4	6	1	11	23.72	0.82
Cypress Cr.		3	13	12	13	5	46	23.68	1.11
Flint R.			1	12	5	2	20	23.40	0.75
Total		3	14	28	24	8	77	23.40	1.03
E. pallididorsum	3	14	30	24	15	1	87	22.43	1.10
E. cragini	9	15	28	23	13	1	89	22.21	1.22

	Transverse Scales 12	13	14	15	16	17	N	x̄	SD
E. boschungi									
Buffalo R.			3	11			14	14.79	0.43
Cypress Cr.	2	12	16	13	7		50	14.22	1.09
Flint R.			3	5	7	4	19	15.63	1.01
Total	2	12	22	29	14	4	83	14.64	1.14
E. pallididorsum	3	48	36	8			95	13.52	0.70
E. cragini	13	48	27	3			91	13.22	0.73

Oklahoma—Delaware Co.: KU 2416 (3) trib. of Elk R., 1 mi E of Turkey Ford, 22 June 1940. Mayes Co.: KU 6895 (14) Spring Cr., 4 mi S of Locust Grove, 27 June 1961; UAIC 1100 (10) brook trib. of Spavinaw Cr., 3.5 mi SE of Strange, 6 November 1950.

Etheostoma pallididorsum Distler and Metcalf. Arkansas—Montgomery Co.: KU 6158 (18 paratypes) small trib. of Caddo R., 1 mi W of Caddo Gap (T4S; R25W; Sec. 14), 6 April 1961; KU 6921 (32 paratypes) Caddo R., 8.5 mi W of Black Springs (T3S; R27W; Sec. 26), 28 June 1961; UAIC 1811 (3 paratypes) Caddo R., 1.2 mi W of Caddo Gap, 6 April 1961; UAIC 3516 (49 topotypes) Caddo R., 8.5 mi W of Black Springs on Ark. Hwy. 8 (T3S; R27W; Sec. 26), 17 April 1969; UAIC 3518 (16) trib. of Caddo R., 1 mi W of Caddo Gap (T4S; R25W; Sec. 14), 17 April 1969.

Diagnosis.—Distinguished from other members of the stippled darter (*Etheostoma punctulatum*) species group of the subgenus *Oligocephalus* by a combination of the following characters: bold, blue-black subocular bar; three prominent dorsal saddles, one on the posterior of the nape, one beneath the posterior of the first dorsal fin and one immediately posterior to the second dorsal fin. Vertebrae number 35 to 37, usually 36; pectoral rays number 12 to 14, usually 13; and pored lateral line scales number 30 to 44, usually 34 to 38.

Description.—Frequency distribution of scale, fin-ray, vertebrae, and cephalic pore counts for *E. boschungi* are given in Tables 1–4. Proportional measurements of the holotype and 11 paratypes are given in Table 5. The general body shape of *E. boschungi* is illustrated in Fig. 1.

The body is scaled except for the breast and prepectoral area. Nape squamation is generally characterized by small partially embedded scales which are usually more numerous on the posterior one-half to one-third of the nape. In a few specimens the nape is naked except for three to six embedded scales. The cheeks are naked. The opercles are naked except for one to six partially embedded scales along the posterior margin of the opercular flap immediately ventral to the opercular spine. These scales are absent in the Flint River population. The lateral line is incomplete with 30 to 44 pored scales. Unpored scales in the lateral series range from 6 to 19. Caudal peduncle scales range from 21 to 25, usually 23 or 24. Scales in transverse series range from 12 to 17, usually 14 or 15.

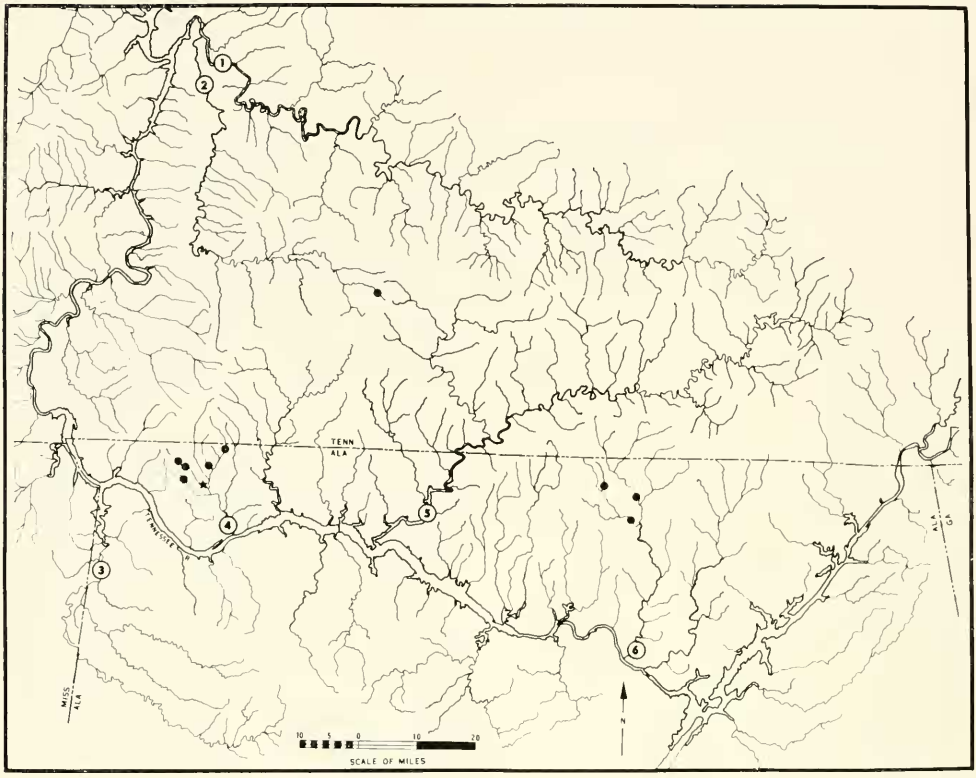

Figure 2. Distribution of *E. boschungi*. Star represents the type locality. Selected tributary systems of the Tennessee River are numbered: 1 Duck; 2 Buffalo; 3 Bear Creek; 4 Cypress Creek; 5 Elk River; 6 Flint River.

Dorsal spines range from 9 to 12 (usually 10 or 11); dorsal soft rays range from 10 to 13 (usually 11 or 12); left pectoral rays range from 12 to 14 (usually 13); and branched caudal rays range from 12 to 17 (usually 14 or 15). The anal fin typically has two spines and 6 to 10 soft rays (usually 8 or 9). Branchiostegal rays typically number six on each side. The branchiostegal membranes are narrowly joined to overlapping. The frenum is broad and well developed. Vertebrae in 28 specimens ranged from 35 to 37 (usually 36).

The infraorbital canal is complete and typically has seven pores. The preoperculomandibular canal is complete, usually with 10 pores. The supratemporal canal is widely interrupted, each branch usually having two pores. There is typically a single coronal pore.

Adult males with breeding tubercles have been taken in November, December, and January, but the tubercles do not appear to be fully developed. The maximum development observed thus far was on a male 43.5 mm SL taken at the type locality on 25 January 1970 (UAIC 3961). Tubercles are absent from the scales except for two to three scales around the anus which have a single small tubercle on each scale. Each of the anal spines and rays has a single row of tubercles which extends from near the base of the element almost to the tip. Tubercles on the anal spines are considerably smaller than those on the anal rays. The largest tubercles are present on the basal portion of the rays and these decrease in size toward the margin of the fin. Tubercles on the pelvic fin are present only on the basal two-thirds to three-fourths of the ventral surface of the outer two pelvic rays. All females examined lacked breeding tubercles.

Coloration of Males.—The following color description is based on specimens taken at

Table 2. Frequency distribution of fin rays in *Etheostoma boschungi*, *E. pallididorsum*, and *E. cragini*.

	Dorsal Spines									
	6	7	8	9	10	11	12	N	$\bar{x}$	SD
E. boschungi										
Buffalo R.				6	7	2		15	9.73	0.70
Cypress Cr.					18	34	1	53	10.68	0.51
Flint R.				5	13	3		21	9.90	0.62
Total				11	38	39	1	89	10.34	0.71
E. pallididorsum			7	59	33	2		101	9.30	0.62
E. cragini	1	2	16	52	24	1		96	9.03	0.80

	Dorsal Soft Rays						
	10	11	12	13	N	$\bar{x}$	SD
E. boschungi							
Buffalo R.		7	8		15	11.53	0.52
Cypress Cr.	1	25	23	4	53	11.40	0.68
Flint R.		2	16	3	21	12.05	0.50
Total	1	34	47	7	89	11.67	0.64
E. pallididorsum	2	39	43	17	101	11.74	0.76
E. cragini	10	51	34	1	96	11.27	0.66

	Pectoral Rays							
	9	10	11	12	13	14	N	$\bar{x}$	SD
E. boschungi									
Buffalo R.				4	8	3	15	12.93	0.73
Cypress Cr.				10	41	2	53	12.85	0.45
Flint R.				9	12		21	12.57	0.51
Total				23	61	5	89	12.80	0.53
E. pallididorsum		6	63	30	2		101	11.28	0.60
E. cragini	1	15	66	12	1		95	10.97	0.61

	Anal Rays							
	6	7	8	9	10	N	$\bar{x}$	SD
E. boschungi								
Buffalo R.		1	11	3		15	8.13	0.52
Cypress Cr.	1	8	30	14		53	8.08	0.70
Flint R.		2	8	10	1	21	8.48	0.75
Total	1	11	49	27	1	89	8.18	0.70
E. pallididorsum		38	56	7		101	7.69	0.60
E. cragini	22	68	6			96	6.83	0.52

	Caudal Rays									
	11	12	13	14	15	16	17	N	$\bar{x}$	SD
E. boschungi										
Buffalo R.				6	6			12	14.50	0.52
Cypress Cr.		1	3	38	5			47	14.00	0.51
Flint R.					17	3	1	21	15.24	0.54
Total		1	3	44	28	3	1	80	14.40	0.74
E. pallididorsum		2	20	51	20			93	13.96	0.72
E. cragini	3	18	40	22				83	12.98	0.80

the type locality on 22 November 1969, 7 December 1968, 22 December 1971, 25 January 1970 and from Copeland Branch (Flint River drainage) in Madison County, Alabama on 24 October 1970. Sexual dichromatism is pronounced in adults with the males being more brightly colored than the females. The most brightly colored male observed was collected 25 January 1970 at the type locality.

Table 3. Number of vertebrae in *Etheostoma boschungi, E. pallididorsum,* and *E. cragini.*

	33	34	35	36	37	N	$\bar{x}$	SD
E. boschungi			4	22	2	28	35.93	0.42
E. pallididorsum		1	24	6		31	35.16	0.45
E. cragini[1]	11	38	6	1		56	33.95	0.62

[1] Includes data from Bailey and Gosline (1955).

The olivaceous to brown dorsum is typically crossed by three dark brown saddles. The first saddle crosses the posterior part of the nape just anterior to the spinous dorsal origin. In some specimens the saddle extends ventrally to or just below the lateral line. The second saddle usually passes under the posterior-most spine of the first dorsal fin and touches the base of the first ray in the second dorsal fin. It extends ventrally to merge with the dark brown blotches along the lateral line. The third saddle is four to six scales wide and is situated immediately posterior to the second dorsal fin and extends ventrally to the lateral line. In some specimens there are one or two poorly defined saddles under the spinous and soft dorsal fins and one across the posterior portion of the caudal peduncle. These saddles are not as large or as intense as the three saddles previously described.

The dark brown to blue-black blotches along the lateral line are extremely variable in size and shape, but they are generally more prominent on the posterior one-half to two-thirds of the body. In some cases the blotches appear to be broken into several smaller blotches with light areas between them. In others, the larger blotches merge to form a very irregular band along the lateral line. There are usually a few scales with dark brown to black centers in the pale area above the lateral blotches. The pale dorsal and dorsolateral areas are suffused with light orange pigment which is usually more intense posteriorly.

Below the lateral blotches the ventrolateral and ventral surfaces of the body are suffused with orange pigment which obscures the underlying scattered melanophores. In the area where the ventrolateral orange pigment merges with the dark brown lateral blotches, the body is an iridescent greenish-yellow color. The orange color of the venter is more intense than that of the ventrolateral surfaces and is slightly more intense posteriorly. The anterior one-fourth to one-third of the venter has scattered melanophores which are more numerous and intense towards the base of the pelvic fins. At the posterior base of the pelvic fins the melanophores are concentrated into a narrow black band which extends dorsally along the posterior base of the pectoral fin, terminating just below the lateral line. The breast and isthmus are orange with scattered melanophores which are more concentrated on the posterior part of the breast, giving it a grayish-black appearance. The prepectoral area is light orange with scattered melanophores.

Table 4. Frequency distribution of cephalic canal pores in *Etheostoma boschungi, E. pallididorsum,* and *E. cragini.*

	Infraorbital Canal Pores						
	6	7	8	9	N	$\bar{x}$	SD
E. boschungi		56	2		58	7.03	0.18
E. pallididorsum		39	7		46	7.15	0.36
E. cragini	1	21	16	2	40	7.48	0.64

	Preoperculomandibular Canal Pores					
	9	10	11	N	$\bar{x}$	SD
E. boschungi	3	54	1	58	9.97	0.26
E. pallididorsum	9	36	1	46	9.83	0.44
E. cragini	2	33	5	40	10.08	0.42

Table 5. Proportional measurements of *Etheostoma boschungi*, expressed in thousandths of standard length.

	Holotype TU 79424	Paratypes ♂ TU 79425, UAIC 3961, UAIC 3774, UF 18424, UMMZ 197692 N = 6		Paratypes ♀ TU 79426, UAIC 3206, UAIC 3774, UMMZ 197692, UMMZ 197693 N = 6	
		Range	$\bar{x}$	Range	$\bar{x}$
Standard length (mm)	50.7	40.3–50.7	45.7	44.3–51.6	47.6
Body depth at dorsal origin	202	200–222	208	200–211	205
Distance from soft dorsal origin to anal origin	185	169–190	182	171–186	175
Caudal peduncle depth	114	101–114	109	107–112	109
Caudal peduncle length	231	222–236	229	233–249	240
Predorsal length	348	342–361	351	338–360	350
Spinous dorsal base	295	284–296	291	260–293	276
Soft dorsal base	184	151–184	172	151–177	166
Caudal fin length	220	197–225	211	207–217	212
Anal base	140	121–141	136	105–134	123
Longest dorsal spine	129	114–134	126	106–119	112
Longest dorsal soft ray	156	131–156	140	129–139	135
First anal spine	97	80–87	83	63–85	73
Longest anal soft ray	139	120–140	133	130–143	134
Longest pectoral ray	245	220–247	237	228–244	235
Pelvic fin length	219	200–219	211	186–214	204
Head length	321	305–324	317	303–318	311
Head depth at occiput	160	157–174	164	157–167	163
Tip of snout to junction of gill membrane	148	115–166	139	118–146	132
Junction of gill membrane to pelvic insertion	166	164–175	170	171–176	172
Upper jaw length	101	92–102	100	90–100	96
Snout length	79	67–82	76	71–79	76
Orbit length	75	74–82	76	71–82	76
Fleshy interorbital width	59	57–60	58	53–61	57
Snout tip to pelvic insertion	312	301–319	312	290–322	309

Dorsally the head is olivaceous to brown with some yellow-orange pigment present. The frenum and central portion of the upper lip are olivaceous. Laterally the upper lip is bright orange. The lower jaw is bright orange with scattered melanophores which are more numerous on the chin. The gular region, branchiostegal membranes, cheeks, and ventral part of the opercle are bright orange. Moderate to large melanophores are present on the cheeks and ventral surface of the opercle. Dorsally the opercle is olivaceous to brown and is suffused with orange pigment. A very bold blue-black subocular bar is present. The width of the bar is usually more than half the diameter of the orbit. A narrow dark brown to black postorbital bar is present just below the lateral canal.

The spinous dorsal fin has a blue-black marginal band which is very narrow on the anterior one-fourth to one-third of the fin, but gradually increases in width and intensity posteriorly. In some specimens the marginal band on the anterior portion of the fin is reduced to a small cluster of melanophores on the interradial membrane. Beneath the marginal band is a broad bright red-orange submarginal band. The band is approximately the same width throughout its length, but is slightly more intense posteriorly. The basal portion of the spinous dorsal fin below the submarginal red-orange band is bluish-gray to black. The soft dorsal fin has four or five longitudinal blue-black bars which are formed by concentrations of melanophores centered on the fin rays. The usual distributions of the bars are as follows: the first bar is marginal or submarginal; the second bar is just above the branching of the fin rays; the third is approximately midway between the second bar and the base of the fin; the fourth bar is at or just above

the base of the fin. The fifth bar, present in some specimens, is spaced between the second and third or third and fourth bar. The light area between the bars is suffused with a yellow-orange pigment which is most prominent on the anterior portion of the fin. In some specimens the first ray is light orange. The anal fin spines and interradial membrane are bright orange. Pigmentation of the anal fin is similar to that of the second dorsal fin except that the bars in the anal fin are more prominent. There are usually five or six dark bars on the caudal fin. The dark pigment of the bars is restricted to the fin rays. In some specimens the bars converge forming an irregular pattern. The pale area between the bars is suffused with yellow-orange which is slightly brighter than that of the second dorsal. The procurrent caudal rays are orange. On the pectoral fin, which is suffused with light yellow-orange pigment, there are usually six to eight dusky bars, poorly developed in some specimens. Usually, clustered melanophores form an oval blotch on the base of the pectoral fin. The pelvic fin has scattered melanophores on the rays and membranes which obscure the vague banded pattern when present. The melanophores are usually more numerous on the membrane towards the basal portion of the fin. Yellow-orange to orange pigment is most pronounced along the pelvic spine.

Coloration of Females.—In general, the pigmentation pattern of adult females is similar to that of males, but the intensity of the yellow and orange colors is greatly reduced. Melanophores along the ventrolateral and ventral surfaces of the body are larger and more numerous on females than on males. On the lower part of the cheek and opercle the melanophores tend to be grouped into small clusters forming a pattern of irregular blotches. In females, the blue-black suborbital bar is usually narrower and less pronounced than in males. The intense concentration of melanophores on the breast and the band of pigment that encircles the ventral half of the body behind the pectoral and pelvic fins of males is absent in females.

Habitat and Species Associates.—*E. boschungi* has been taken most frequently in clean, medium current, second and third order streams ranging in width from 10 feet to 20 feet, and ranging in depth from less than 6 inches to nearly 5 ft. With few exceptions, *E. boschungi* has been found to be associated with accumulations of leaves in areas of relatively low water velocity.

Of eleven specimens of *E. boschungi* taken from Lindsey Creek, 7 December 1968, seven were from loose accumulations of leaves, two were from a partially submerged tangle of roots, and one was from a marginal pool (8–10 in. deep) of still, clear water where the bottom consisted of angular chert rocks 1.5 to 2 inches thick. One specimen was removed from the stomach of a sunfish.

Three specimens were taken at the same locality on 29 January 1969, despite the fact that the water level was 10 to 12 inches higher than on 7 December and that many of the loose accumulations of leaves had either been washed downstream or had become more compact masses.

By 22 March 1969, most of the accumulations of leaves had been washed downstream. Two specimens of *E. boschungi* were taken in one of the few remaining masses of leaves.

There is a small spring (*ca.* 20 gpm) at the type locality whose waters flow a distance of approximately 60 feet before entering the creek. No specimens of *E. boschungi* were taken from the spring or the spring run by us or any other collectors. In view of the fact that *E. cragini* and *E. pallididorsum* typically inhabit springs and spring runs populated with herbaceous vegetation (Blair and Windle, 1961; Cross, 1967; Pfleiger, 1971), it is significant that *E. boschungi* was not found in the spring or spring run, nor was it found in any of the 67 springs of the southern bend of the Tennessee River system which were examined by Armstrong and Williams (1971).

A collection made in Lindsey Creek, upstream from the type locality on 7 December 1968 yielded a single specimen of *E. boschungi*. The bottom at this locality consisted of coarse sand overlain by large quantities of leaves.

Several collections were made at a point approximately 6 miles upstream from the type locality. Four of the six specimens taken from this locality on 29 January 1969 (USNM 206420) were taken from a pool which was *ca.* 25 feet wide and *ca.* 5 feet deep at its deepest point. These four specimens were taken from among leaves in the deepest portion of the pool. The other two

specimens collected on this occasion were taken downstream from the pool among leaves in water that was less than 2 feet deep. This locality was revisited on 22 March 1969, at which time we noted a reduction in the quantity of leaves on the bottom of the pool. A single specimen of *E. boschungi* was taken from the pool. A third visit to this locality on 4 October 1969, yielded no specimens of *E. boschungi*.

Although many of the 21 specimens of *E. boschungi* taken from Copeland Branch (Flint River drainage) on 24 October 1970, were taken from among leaves and from clumps of rooted plants, some specimens were taken from midstream areas where water flow was sufficient to prevent accumulation of leaves on the gravel bottom.

Known water temperatures during times of capture ranged from 7° C (22 December 1971) to 14° C (22 March 1969).

Specimens were taken on clear days (7 December 1968; 22 March 1969), a clear night (22 December 1971), and on days of rain (29 January 1969; 24 October 1970).

Species taken at the type locality in addition to *E. boschungi* include: *Lampetra aepyptra, Esox americanus, Hypentelium nigricans, Catostomus commersonii, Campostoma anomalum, Semotilus atromaculatus, Hemitremia flammea, Clinostomus funduloides, Notropis ardens, Notropis chrysocephalus, Fundulus catenatus, Fundulus olivaceous, Gambusia affinis, Etheostoma simoterum, Etheostoma duryi, Etheostoma squamiceps, Etheostoma flabellare, Etheostoma caeruleum, Lepomis cyanellus,* and *Cottus carolinae*.

Species taken at other localities in Lindsey Creek at which *E. boschungi* was taken include the species noted above as well as *Erimyzon oblongus, Chrosomus erythrogaster, Micropterus punctulatus, Lepomis megalotis,* and *Lepomis macrochirus*.

Species taken with *E. boschungi* in Copeland Branch include *Notropis chrysocephalus, Hemitremia flammea, Campostoma anomalum, Semotilus atromaculatus, Gambusia affinis, Lepomis cyanellus, Etheostoma squamiceps,* and *Etheostoma simoterum*.

Species taken with *E. boschungi* from the Buffalo River on 11 March 1969, include *Hypentelium nigricans, Campostoma anomalum, Clinostomus funduloides, Pimephales notatus, Etheostoma duryi, Etheostoma flabellare, Etheostoma squamiceps,* and *Cottus carolinae*.

Stomach contents of many centrachids were examined and one paratopotype (UAIC 3204) of *E. boschungi* (52 mm SL) was found to have been consumed by a *Lepomis cyanellus* (115 mm SL). Circumstances of capture and preservation were such that we are certain that the darter was not eaten by the sunfish in the seine or in the collecting jar.

Range.—Etheostoma boschungi is presently known from one locality in the headwaters of the Buffalo River in Lawrence County, Tennessee, six localities in the Cypress Creek drainage in Lauderdale County, Alabama and three localities in the Flint River drainage in Madison County, Alabama (Fig. 2). *Etheostoma boschungi* is the only species of the stippled darter (*E. punctulatum*) group known to occur in drainages east of the Mississippi River. Collecting efforts concentrated in the appropriate habitat in the Tennessee River drainage in north Alabama and west Tennessee may reveal the presence of additional populations. In recent years, however, intensive collecting in the Bear Creek system (Wall, 1968), Elk River system (Jandebeur, 1972), and 67 springs in the southern bend of the Tennessee River (Armstrong and Williams, 1971) yielded no specimens. These reports are based on a total of 300 collections.

Relationships.—Etheostoma boschungi appears to be most closely related to *Etheostoma cragini* Gilbert, 1885 and *Etheostoma pallididorsum* Distler and Metcalf, 1962. Blair (1964) suggested that the latter two species and *Etheostoma punctulatum* (Agassiz, 1854) comprise a natural species group. We agree and are of the opinion that *E. boschungi* is an eastern representative of this complex. The relationship of *E. boschungi* to *E. cragini* and *E. pallididorsum* is exhibited by similarities in the following characters: coloration of breeding males, distribution of breeding tubercles, certain fin ray, scale and cephalic canal pore counts, and general physiognomy.

The specific status of *E. pallididorsum* has been questioned by Ramsey and Suttkus (1965). We are of the opinion, however, that Blair's (1964) observations of behavioral and morphological differences in addition to data we have presented are sufficient to

support continued recognition of the specific status of *E. pallididorsum*. This problem will be explored more fully in a subsequent paper which deals with the distribution and relationship of all members of the stippled darter species group.

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